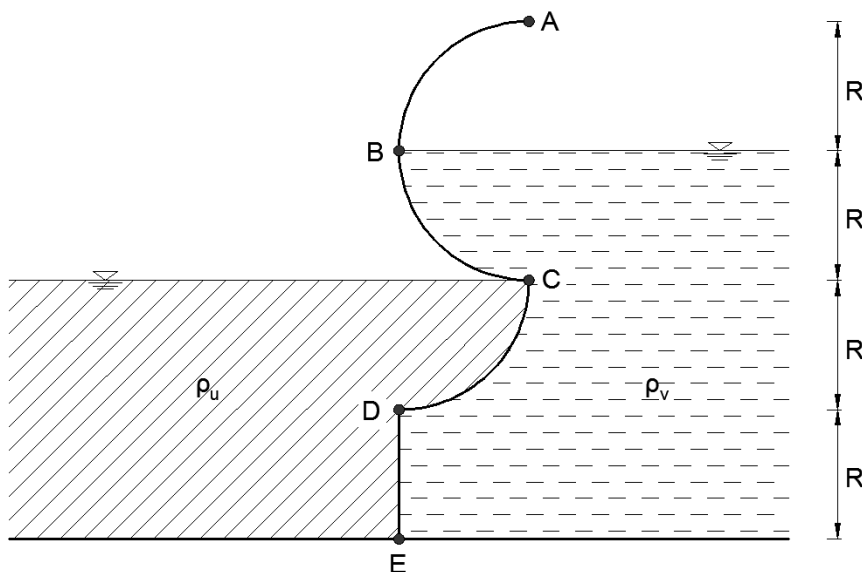
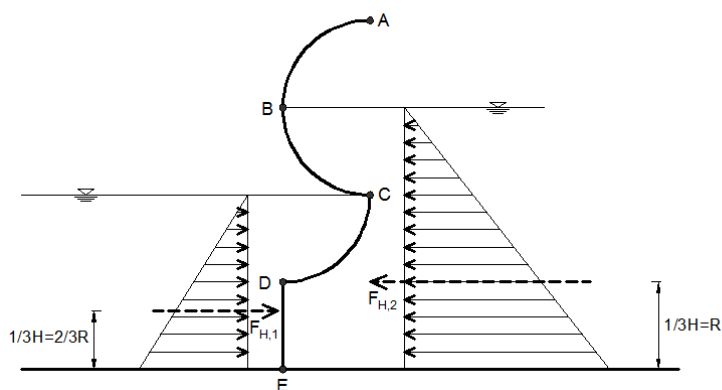


1) (25 bodova)

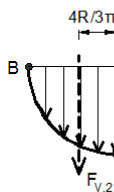
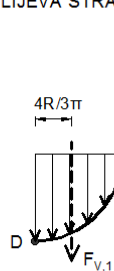
 Pomoću dijagrama hidrostatskog tlaka nađite veličinu i smjer rezultantne hidrostatske sile na 1m širine plohe od točke A do E. Zadano je: $\rho_u=800 \text{ kg/m}^3$, $\rho_v=1000 \text{ kg/m}^3$, $R=2,0 \text{ m}$.


HORIZONTALNA KOMPONENTA DIJAGRAMA TLAKA NA PLOHU A-E

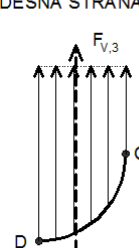


VERTIKALNA KOMPONENTA DIJAGRAMA TLAKA NA PLOHU A-E

LIJEVA STRANA C-D



DESNA STRANA C-D



$$F_{H,1} = P_{dijagrama} \cdot 1,0 = \frac{1}{2} \cdot \rho_u \cdot g \cdot 2R \cdot 2R \cdot 1,0 = \frac{1}{2} \cdot 0,8 \cdot 9,81 \cdot 4 \cdot 4 \cdot 1,0 = 62,78 \text{ kN}$$

$$F_{H,2} = P_{dijagrama} \cdot 1,0 = -\frac{1}{2} \cdot \rho_v \cdot g \cdot 3R \cdot 3R \cdot 1,0 = -\frac{1}{2} \cdot 1,0 \cdot 9,81 \cdot 6 \cdot 6 \cdot 1,0 = -176,58 \text{ kN}$$

$$F_H = F_{H,1} + F_{H,2} = 62,78 - 176,58 = -113,8 \text{ kN}$$

$$F_{V,1} = V_{tijela} \cdot \rho \cdot g = -\frac{2^2 \pi}{4} \cdot 1,0 \cdot 0,8 \cdot 9,81 = -24,64 \text{ kN}$$

$$F_{V,2} = V_{tijela} \cdot \rho \cdot g = -\frac{2^2 \pi}{4} \cdot 1,0 \cdot 1,0 \cdot 9,81 = -30,80 \text{ kN}$$

$$F_{V,3} = V_{tijela} \cdot \rho \cdot g = \left(\frac{2^2 \pi}{4} + 2 \cdot 2 \right) \cdot 1,0 \cdot 1,0 \cdot 9,81 = 70,04 \text{ kN}$$

$$F_V = F_{V,1} + F_{V,2} + F_{V,3} = -24,64 - 30,80 + 70,04 = 14,60 \text{ kN}$$

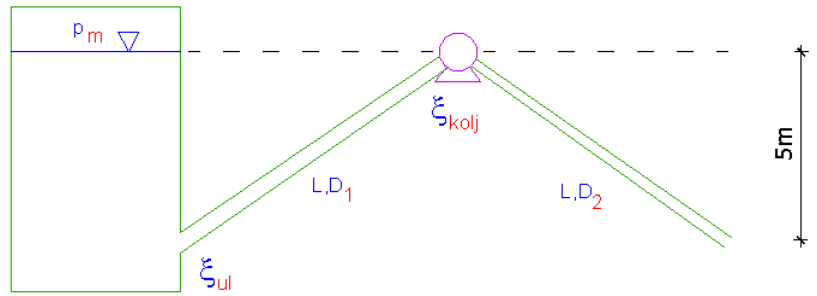
REZULTANTNA SILA

$$R = \sqrt{F_H^2 + F_V^2} = \sqrt{-113,8^2 + 14,6^2} = 114,73 \text{ kN}$$

$$\text{tg} \alpha = \frac{14,6}{113,8} = 0,128 \rightarrow \alpha = 7,31^\circ$$

2) (25 bodova)

Za cjevovod kao na slici potrebno je odrediti brzine vode u cijevima i protok kroz cijevi. Nacrtati energetska i piezometarska linija. Zadano je: $\rho=1000 \text{ kg/m}^3$; $H_{pump}=15\text{m}$; $L=200\text{m}$; $D_1=0,3\text{m}$; $D_2=0,2\text{m}$; $p_m=-19,62 \text{ kPa}$; $\lambda_1=\lambda_2=0,02$; $\xi_{ul}=0,5$; $\xi_{kolj}=f(v_1)=0,2$



$$5-2+15 = \frac{v_1^2}{2g} \left(\xi_{ul} + \lambda \frac{L}{D_1} + \xi_{kolj} \right) + \frac{v_2^2}{2g} \left(\lambda \frac{L}{D_2} + 1 \right)$$

$$18 = v_1^2 \cdot 0,715 + v_2^2 \cdot 1,07$$

$$Q_1 = Q_2$$

$$v_1 \cdot \frac{D_1^2 \pi}{4} = v_2 \cdot \frac{D_2^2 \pi}{4}$$

$$v_1^2 \cdot D_1^4 = v_2^2 \cdot D_2^4$$

$$v_1^2 = \frac{v_2^2 \cdot D_2^4}{D_1^4} = v_2^2 \cdot \frac{0,2^4}{0,3^4} = 0,2v_2^2$$

$$18 = 0,2v_2^2 \cdot 0,715 + v_2^2 \cdot 1,07$$

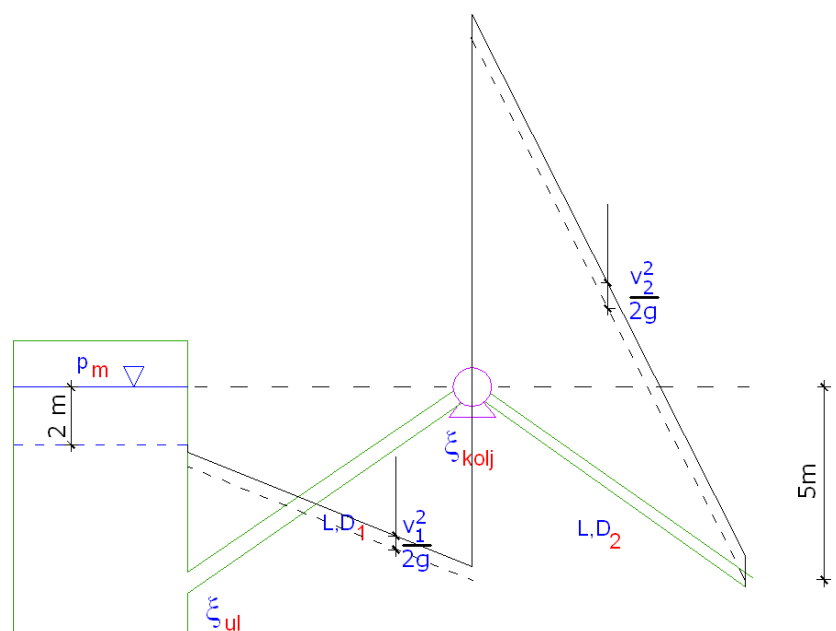
$$v_2^2 = 14,84$$

$$v_2 = 3,85 \text{ m/s}$$

$$v_1 = \sqrt{0,2v_2^2}$$

$$v_1 = 1,72 \text{ m/s}$$

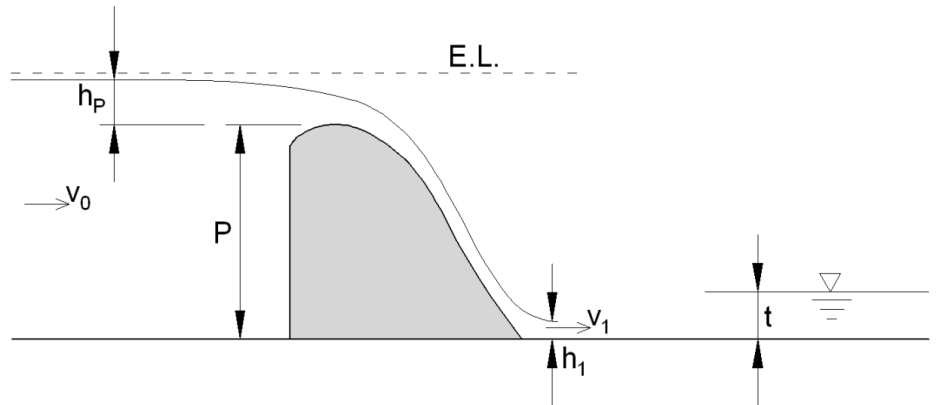
$$Q = v_1 \cdot \frac{D_1^2 \pi}{4} = 1,72 \cdot \frac{0,3^2 \pi}{4} = 0,122 \text{ m}^3/\text{s}$$



3) (15 bodova)

Potrebno je provjeriti potopljenost vodnog skoka ($h_2 < t$) koji se pojavljuje iza preljeva praktičnog profila s koeficijentom prelijevanja $C_p = 0,41$, uz uvjet normalne dubine $t = 0,5\text{m}$ nizvodno od preljeva.

Zadano je: $h_p = 0,5\text{m}$ (visina prelijevanja); $P = 3\text{m}$ (visina preljeva od dna); $B = 10\text{m}$ (širina preljeva); $v_1 = 1,77\text{ m/s}$ (brzina u profilu prve spregnute dubine).



$$Q = C_p \cdot B \cdot \sqrt{2g} \cdot h_p^{3/2} = 2,98 \text{ m}^3 / \text{s}$$

$$q = \frac{Q}{B} = 0,298 \text{ m}^3 / \text{s} / \text{m}' \rightarrow h_1 = \frac{q}{v_1} = \frac{0,298}{1,77} = 0,168 \text{ m}$$

$$Fr_1 = \frac{v_1}{\sqrt{gh_1}} = 1,38$$

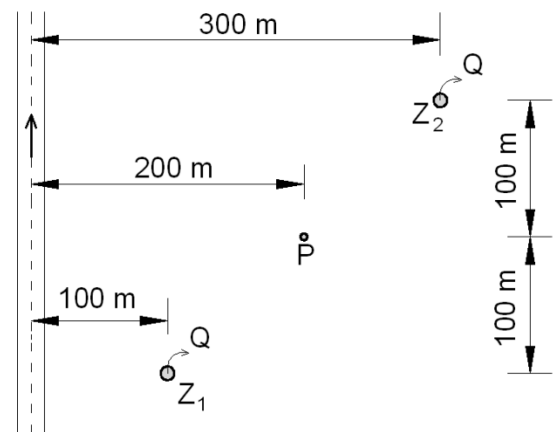
$$h_2 = \frac{h_1}{2} \left(\sqrt{1 + 8 \cdot Fr_1^2} - 1 \right) = 0,25 \text{ m} \rightarrow h_2 < t \text{ (potopljeni vodni skok)}$$

4) (20 bodova)

Iz dva zdenca Z_1 i Z_2 položena u vodonosniku pod tlakom crpi se jednaka količina $Q = 0,1 \text{ m}^3/\text{s}$. Zdenca se nalaze na međusobnoj udaljenosti prema slici te su udaljeni od vodotoka 100 m i 300 m. Potrebno je odrediti sniženje s_p u piezometru P .

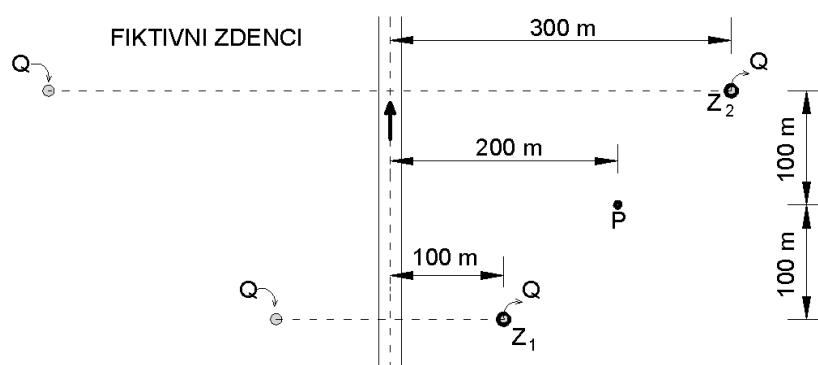
Zadano je: $k = 0,01 \text{ m/s}$; $M = 10\text{m}$ (debljina vodonosnog sloja); $R = 350\text{m}$ (radijus utjecaja obaju zdenaca).

$$s_p = 2 \cdot \frac{Q}{2\pi kM} \ln \frac{R}{\sqrt{100^2 + 100^2}} - \frac{Q}{2\pi kM} \ln \frac{R}{\sqrt{300^2 + 100^2}}$$



(nema utjecaja "gornjeg" fiktivnog zdenca)

$$s_p = 0,288 - 0,016 = 0,272 \text{ m}$$



Teorija (15 bodova):

1. Što je to relativno mirovanje i kada je ono moguće?
2. Skicirajte i opišite dijagram specifične energije.
3. Što je hidraulički radijus i kako se računa kod korita velike širine ($h/B \rightarrow 0$)?
4. Napišite izraz za silu otpora tijela i objasnite članove.

Uvjeti za usmeni dio ispita: minimalno 50 bodova i točno riješeni 1. i 2. zadatak!